Peer-reviewed papers

Understanding the challenges facing child pedestrian trauma in Victoria 2000-2010

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Abstract

Crashes involving pedestrians are severe in nature due to pedestrians' vulnerability, lack of protection and limited biomechanical tolerance to violent forces if hit by a vehicle. Children are thought to constitute a high-risk sub-group. This paper provides an analysis of serious casualty child pedestrians in Victoria and highlights some important features of these collisions. The findings show that young children (especially males) are at significant risk of serious injury, that the majority of collisions occur on urban roads with speed limits of 50-60km/h, and that (for older children) crossing the road at midblock sections without the aid of pedestrian crossings and (for younger children) emerging from parked vehicles are predominantly problematic. The implications of these findings are discussed, particularly with regard to developing targeted initiatives within the Safe System framework that may achieve significant reductions in child pedestrian injury crashes.

Keywords

Child safety, Countermeasure, Injury, Pedestrian, Road safety

Introduction

While there is a clear and continuing tendency for Australians and other western populations to rely on motor vehicles as a primary mode of transport, walking is another major mode of transport, and still forms a significant component of daily travel routines for most trips. Furthermore, walking has obvious health and wellbeing benefits for children and people of all ages, as well as environmental, social and economic benefits. Governments worldwide recognise this and there has been a major push to encourage increased walking and cycling 1,2].

If initiatives that promote walking and public transport use are successful, however, pedestrian safety concerns in Victoria (and Australia) are likely to grow unless there are concurrent improvements in road safety initiatives. Crashes involving vulnerable road users represent a major road safety problem worldwide and there is growing awareness within the road safety community that vulnerable road users may have their own particular needs and difficulties in using the road transport system.

Indeed, between the 1990s and early 2000s, Australia has enjoyed significant overall reductions in the number of pedestrian deaths and data from various Australian jurisdictions consistently indicate a downward trend in pedestrian deaths and casualties [3-5]. Victorian data, too, show a significant reduction in pedestrian deaths during this period – a reduction from approximately 160 deaths in the late 1980s to 40 deaths in 2003 (Figure 1).

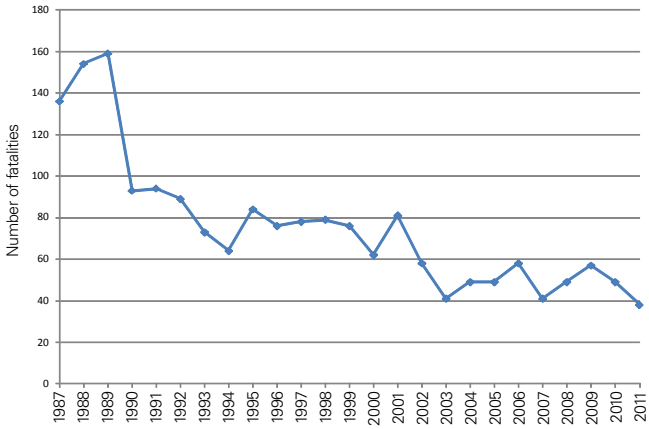

Figure 1. Number of pedestrian fatalities, Victoria 1987-2011

Within this period, two large-step reductions occurred in 1990 and 2003, following the introduction of two separate major speed initiatives in Victoria in 1989 and 2002. The first initiative involved the introduction of automated speed cameras and a boost in random breath testing in 1989. The second initiative was a reduction in the tolerance level of compliance with speed limits along with a range of improvements in speed enforcement in 2002. Despite these major gains, the general trend since 2003 has been for pedestrian deaths to increase in Victoria. In particular, pedestrian deaths have increased markedly from a total of 41 pedestrian fatalities in 2007 [6] to 59 in 2009, but have decreased in the last two years to 38 in 2011 [7]. Moreover, serious casualty data indicate that pedestrians constituted approximately 11% of all road injuries in Victoria in 2010 and 2011.

Traditionally, there are three noted high risk groups of pedestrians: children, the intoxicated, and the elderly. Young children's safety as pedestrians is of particular concern in view of their vulnerability in traffic situations and the special value society places on children. Their vulnerability stems from a number of factors including their smaller stature, cognitive development, unpredictability and lack of experience as road users. Indeed, young children are reported to be a high risk sub-group primarily due to a lack of experience in traffic situations and restricted development of those skills needed to become safe road users. Moreover, children between six and ten years of age appear to be at increased risk, and this is thought to reflect the fact that, at these ages, children are becoming independent and start walking unsupervised [8]. (Adults older than 60 years are at high risk because of changes in their mobility and deteriorating functional performance such as eyesight and hearing, as well as changes in cognitive abilities such as memory and information processing which makes it harder for them to judge distances and the speed of oncoming traffic [9,10]. Intoxicated pedestrians are at risk because of issues similar to intoxicated drivers: their judgement is impaired and reflexes are slowed after consuming alcohol or drugs [11,12]).

This traditional view attributing particular factors to the overall child pedestrian problem is based on data that are up to 15-20 years old, and while this view may still hold, there is a need to conduct current analyses of the contributing factors to child pedestrian injury collisions in Australia to provide a better understanding of current issues. Indeed, there may be significant behavioural changes (such as a decrease in walking activity associated with an increased trend of parents driving their children to school and other activities), or environmental changes (increased congestion, reduced speeds around school zones, changed vehicle mix, etc) that may account for changes in crash and injury profiles. This paper presents an analysis of an 11-year period of fatal and serious injury child pedestrian collisions from 2001 to 2010 in Victoria, as an example of an Australian jurisdiction. The findings are discussed in terms of impact on approaches to managing child pedestrian safety and recommendations for innovative ways to take the next major step forward to eliminating serious child pedestrian trauma.

Method

Victorian Police-reported mass crash data covering the period January 2000 to December 2010 were used in this analysis. Pedestrians aged up to 17 years were extracted from these data and selected crash variables were analysed to highlight the patterns associated with child pedestrian serious casualties. Serious casualty pedestrians are defined as those pedestrians killed or taken to hospital as a result of involvement in a road crash. This subset was segregated into four age groups: 0-4 years, 5-8, 9-12 and 13-17 years. Variables identified for analysis included injury severity, road geometry, Definitions for Classification of Accidents (DCA), time of day and day of week, speed zone, and traffic control type. Aggregate analyses comprised cross-tabulations of these descriptor variables and are presented in graphical format. To enable comparisons between each of the child age groups, percentage contributions of each of the factors have been determined for each of the age groups separately.

Results

Between 2000 and 2010, there were 8178 police-reported pedestrian serious casualties in Victoria, of which 1514 (19%) were children aged 17 years and under. Figure 2 presents age-adjusted pedestrian serious casualty rates per 100,000 population by age group. The Australian estimated residential population (persons) as at 30 June 2001 was used as the standard population in the calculation of these rates. These data show that children aged 13 to 17 years are at high risk, compared with younger age groups of children, but at lower risk than adults aged 18 years and over.

Characteristics of child pedestrian serious injury collisions

The remainder of the analyses presented here examine child pedestrian serious casualties only. Given that the data are aggregated, and the main purpose is to examine differences between age groups, the remainder of the analyses are expressed in percentage terms, so that each of the age groups can be compared relative to each other.

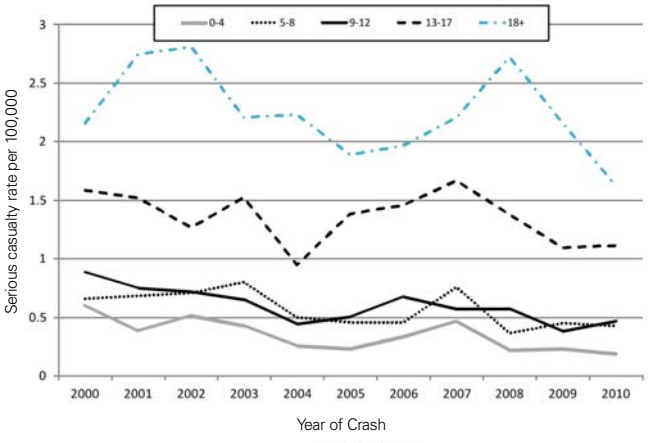

Figure 2. Incidence of all age pedestrian serious casualty rates per 100,000 population (age-adjusted)

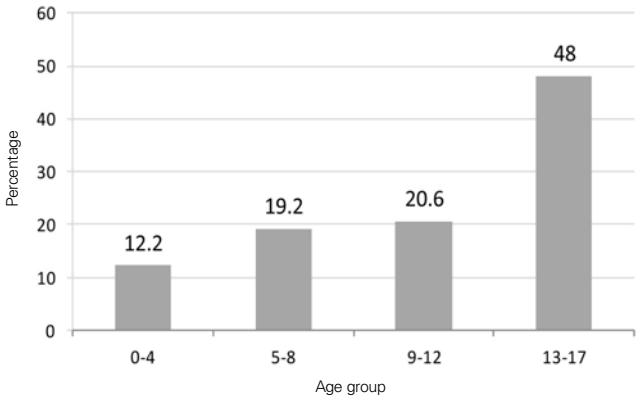

Figure 3. Percentage distribution of child pedestrian serious casualties by age group

First, the overall percentage distribution of serious casualties is shown by age group (Figure 3). Within these age groups, children aged between 13 and 17 years accounted for almost 50% of serious casualties, while the youngest age group (children 4 years and under) comprised only 12%.

Figure 4 shows the breakdown of child pedestrian serious casualties by severity and age group. The majority involved a serious injury, while fatalities comprised a low proportion across all age groups. Over 90% in each age bracket are seriously injured. Regarding fatalities, there was a higher proportion of deaths amongst the youngest children (6.5%), compared with older children.

Moreover, males were at higher risk of fatal or serious injury in all age groups, compared with females, but particularly so for younger age groups up to 12 years of age, comprising approximately 65% of serious casualties (Figure 5). The gender difference was around 30% for each of the age groups but decreased to 10% for the oldest age group, where 55% were males and 45% were females.

The following analyses present information on crash types, location and other environmental characteristics. As above, all analyses examine child pedestrian serious casualties only.

The percentage distribution of pedestrian serious casualties by pedestrian movement type is shown in Figure 6 for each of the four age groups. Not surprisingly, crossing the road is the most problematic movement for pedestrians.

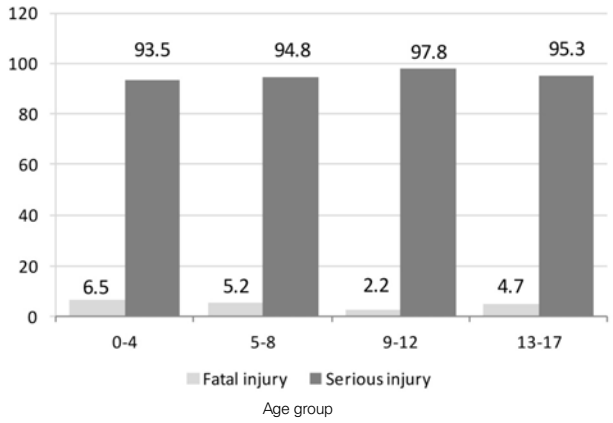

Figure 4. Percentage distribution of child pedestrian serious casualties by age group and injury severity

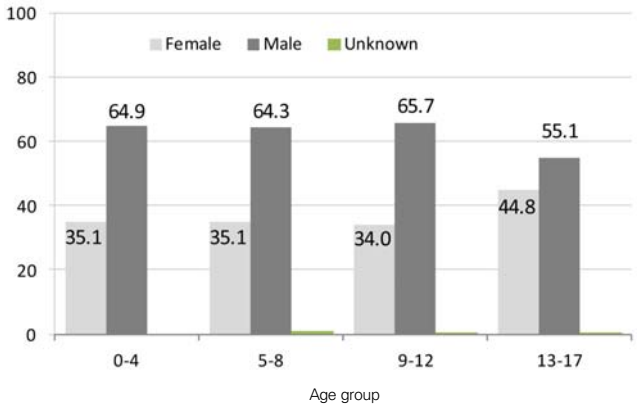

Figure 5. Percentage distribution of child pedestrian serious casualties by age group and gender

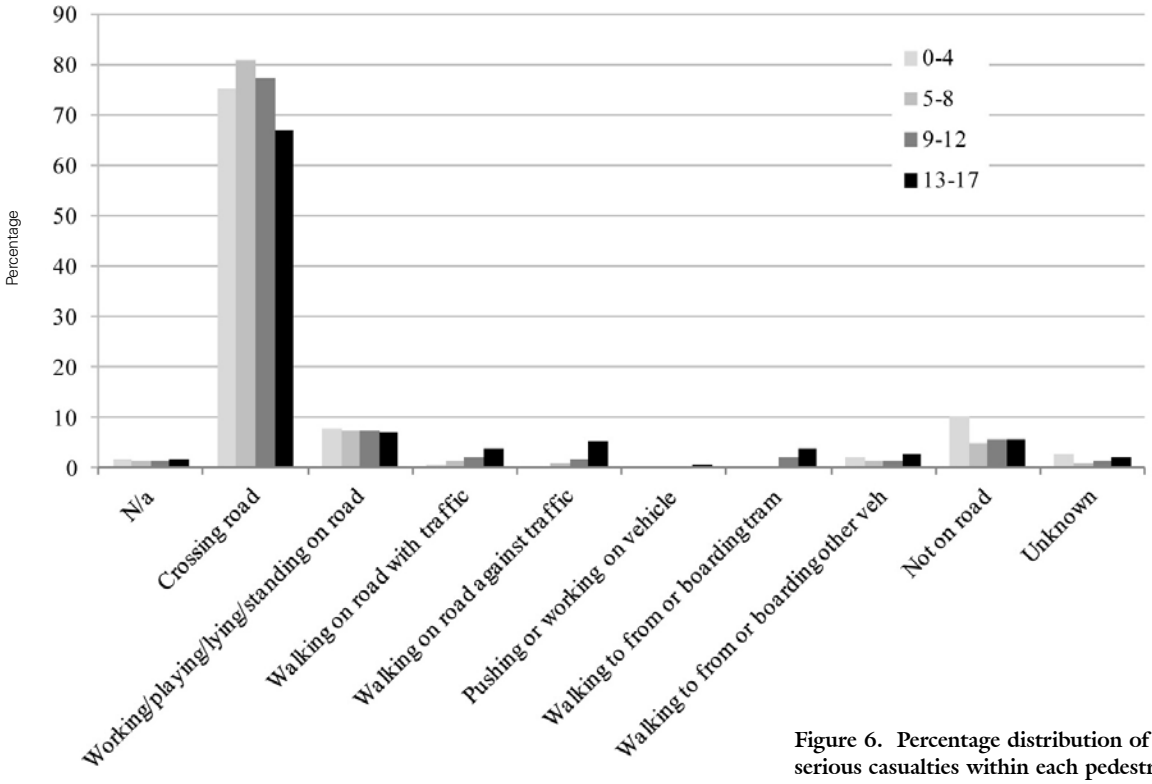

Figure 6. Percentage distribution of child pedestrian serious casualties within each pedestrian movement type

In addition, the Definitions for Classification of Accidents (DCA) chart was used to examine further the types of crashes children are involved in (Figure 7). As a reference, DCAs 100-109 classify pedestrian collisions and are as follows:

- 100: nearside – pedestrian emerging from roadside and colliding with nearside approaching vehicle
- 101: emerging – pedestrian emerging from behind parked vehicle and colliding with nearside approaching vehicle
- 102: farside - pedestrian on road and colliding with farside approaching vehicle
- 103: playing, working, lying or standing on carriageway
- 104: walking with traffic - pedestrian walking on carriageway in parallel (same direction) as vehicular traffic
- 105: facing traffic - pedestrian walking on carriageway in opposite direction to vehicular traffic
- 106: on footpath/median
- 107: driveway - pedestrian hit while on driveway
- 108: struck while boarding or alighting a vehicle
- 109: other pedestrian.

Figure 7 shows that the majority of child pedestrian serious casualties were struck by either a nearside or farside approaching vehicle (approximately 30%, respectively), while crossing the road. In addition, 16% were emerging from behind parked vehicles and were struck by a nearside vehicle. Approximately 4% of children were struck while playing or standing on the carriageway, while 3% were struck on a driveway.

These data are further broken down by age group. Figure 8 shows the three most frequent DCA types by age group.

The data show that older children account for approximately half of the serious casualties resulting from nearside and farside collisions, while much smaller proportions of young children were involved in these collision types. Interestingly, younger children were more likely to be involved in collisions when emerging from behind parked vehicles. These data confirm the issues of crossing from between parked vehicles identified in previous literature.

Figure 9 shows the proportion of collisions by time of day and shows that, for all age groups, the majority of collisions occurred during the afternoon between 2.00 and 4.00 pm. This was particularly so for children aged between 5 and 12 years, suggesting that many collisions occur while walking home from school, or playing in the street after school.

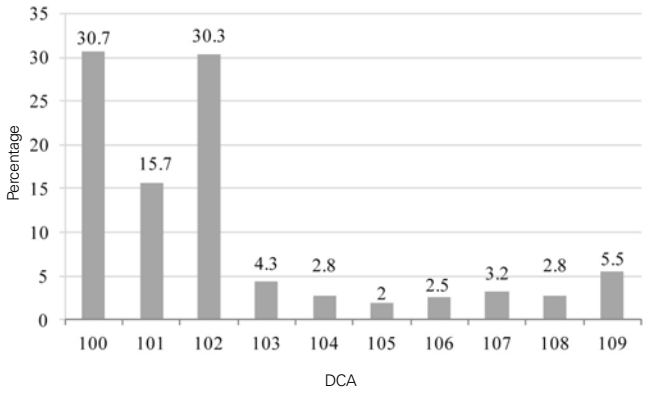

Figure 7. Percentage distribution of child pedestrian serious casualties by DCA

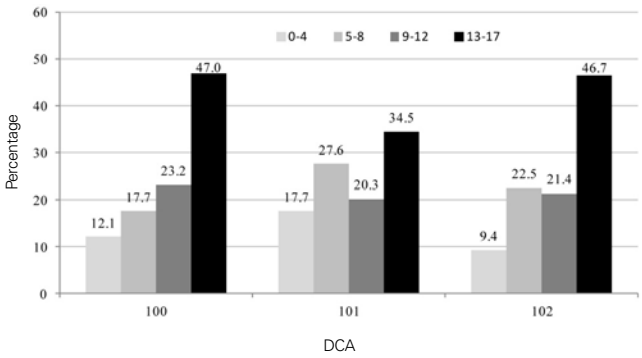

Figure 8. Percentage distribution by age group for three most common DCA types

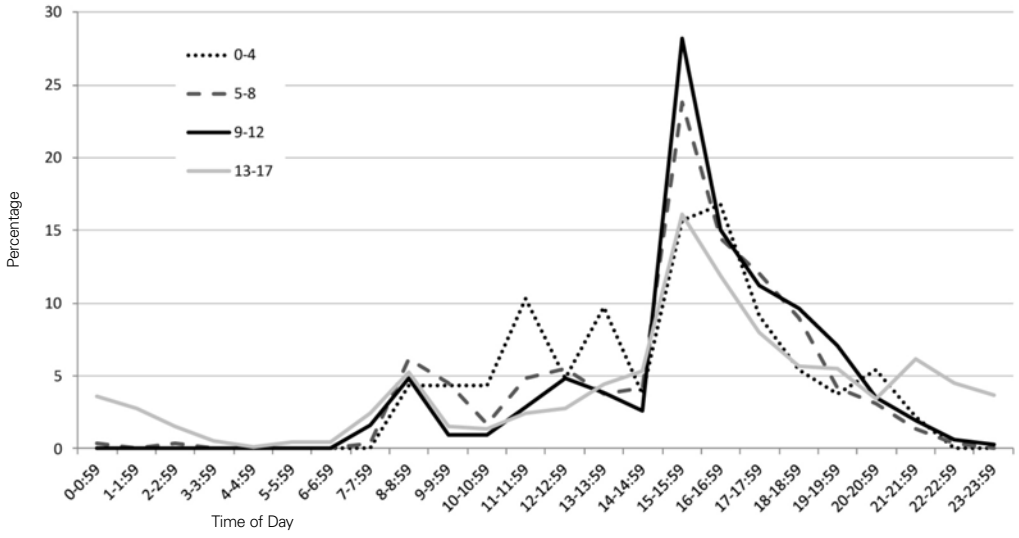

Figure 9. Percentage distribution of child pedestrian serious casualties by time of day

Regarding day of week, there was no clear pattern of when serious casualties occurred (Figure 10).

The remaining analyses examine road geometry and operation. Figure 11 shows the overall proportion of collisions by road geometry and shows that the majority of collisions (60%) occur at mid-block sections of the roadway, with the remaining 40% at intersections.

Further analyses revealed that, overall, children were struck while crossing the road with no traffic control[1] or no crossing facility (80%). Some age group differences were noted. A higher proportion of young children below 8 years of age were struck when crossing with no traffic control compared with older children (85% vs. 76%). In contrast, older children were more likely than younger children to be involved in collisions at stop-go lights (6% vs. 15%) (Figure.12).

Last, speed zone was examined. Figure 13 (next page) shows the distribution of collisions by speed zone. The majority of collisions occurred in 60 km/h and 50 km/h speed zones (44% and 32%, respectively). This was not a surprising finding, given that most walking and crossing of roads occur on urban roads.

Discussion

Despite overall reductions in pedestrian deaths and serious injuries in Victoria over the last two decades, approximately 800 serious casualty collisions involving pedestrians still occur each year, representing approximately 11% of all road injuries in Victoria. Moreover, children under 17 years of age represent a significant proportion of child serious casualty crashes, accounting for almost 20% of all pedestrian casualties; however, little updated information is available regarding crash patterns and types and contributing factors to child pedestrian collisions.

This paper presented updated information on some of the characteristics of collisions involving this road user group. It has provided important information on which effective and innovative countermeasures can be developed within the Safe System approach to reduce the frequency and severity of pedestrian collisions.

There are some limitations in drawing comprehensive conclusions about trauma and collision risk from police-reported data, particularly when addressing vulnerable road users. For example, there is potential for biased reporting, given

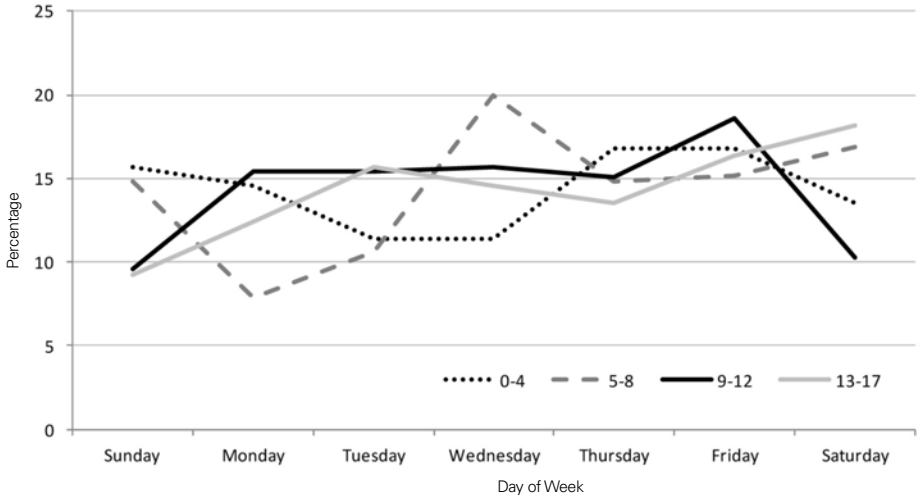

Figure 10. Percentage distribution of child pedestrian serious casualties by day of week

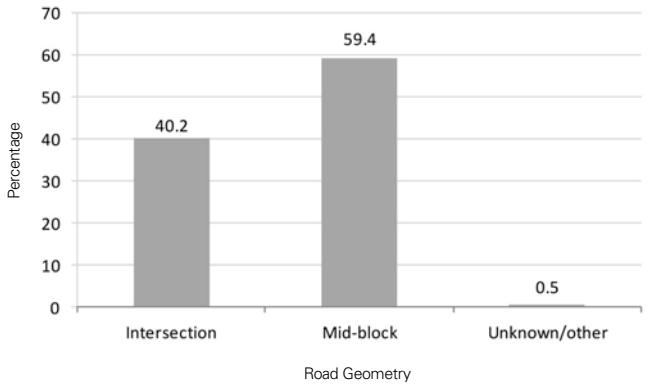

Figure 11. Percentage distribution of child pedestrian serious casualties by road geometry

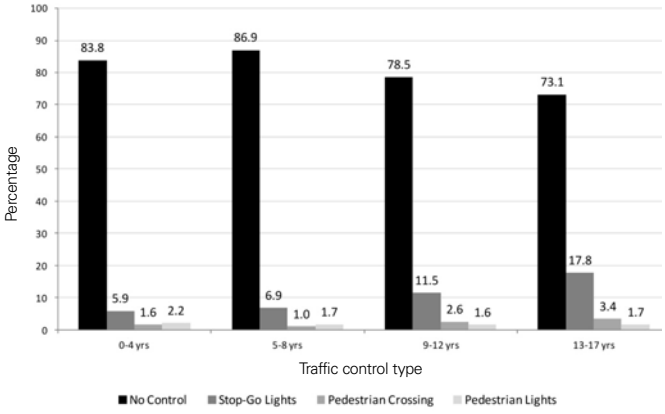

Figure 12. Percentage distribution of child pedestrian serious casualties by traffic control type

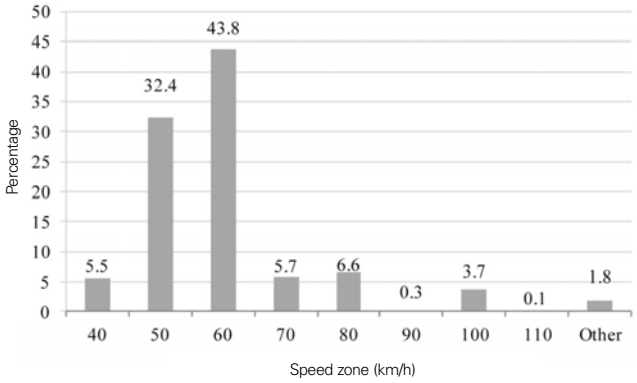

Figure 13. Percentage distribution of child pedestrian serious casualties by speed zone

the high likelihood of the pedestrian being injured (and not the driver). It should also be noted that, due to the way police-reported data are collected and collated, non injury and minor injury collision rates may be underestimated, and can be better understood by validating against hospital data (as discussed below). Furthermore, in-depth information regarding collision and injury causation is lacking in these data sources. Nevertheless, it is important to analyse police-reported data sources to highlight important features of collisions.

The findings showed that males were over-represented in collisions, compared with females, and that approximately 60% of collisions occurred while crossing mid-block sections of road, with the remaining 40% occurring at intersections. With regard to crash type, the majority of collisions occurred on the carriageway, while children were attempting to cross, and most were struck by nearside or farside traffic. These findings were not surprising, given that the most dangerous part of being a pedestrian is crossing the road which involves interaction with vehicles. These findings also revealed that younger children were more likely to be struck while emerging from parked vehicles into the path of an oncoming vehicle. This confirms previous findings that this is a major problem for younger children. Young children have been shown to experience difficulty in choosing a safe location to cross and often cross between parked vehicles [13,14]. Because of their small stature, they have greater difficulty seeing over parked cars and other obstacles, and are in turn more easily hidden by them, making them more difficult for drivers to detect [15,16].

It was interesting to note that these analyses did not identify walking or playing on the road, or driveway collisions, as a major threat to young children, despite previous literature and media interest suggesting these collision types to be of high priority. It is worth noting, however, that other hospital-based data - such as the Victorian Emergency Minimum Dataset (VEMD), an injury surveillance database of injury presentations to emergency departments (ED) in major Victorian public hospitals - identify substantially higher numbers of driveway-related injuries, compared with those identified in the police-reported crash database. This discrepancy may be an artefact of different coding systems, or under-reporting of these incidences to police. Nevertheless, it is worth noting here that between 2005 and 2010 there were at least 77 Victorian Emergency Department presentations for driveway run-over or back-over among children 14 years and under, an average of 13 cases per year. These presentations were evenly distributed across three age groups, 0-4 years, 5-9 years and 10-14 years, each group accounting for approximately 33% of presentations. Injuries to lower extremities were common, followed by multiple injuries, and 31% were admitted to hospital [17].

Another important finding was that the majority of collisions involving children occurred while crossing roads zoned at either 50 or 60 km/h. The evidence is clear that speed has a great impact on pedestrian safety and that pedestrian safety is highly compromised when interacting in traffic where speeds are higher than 30-40 km/h. Indeed, there have been many calls for moderating vehicle speeds in areas with high pedestrian activity and these findings support the critical need for moderating vehicle speed [18-20].

Implications

The findings from this analysis provide some important insights into crash types and collision risk for children in Victoria which have implications for countermeasure development to address the problems within a Safe System framework. Three broad strategies are available for managing child pedestrian safety. These include improvements to road design and operation (especially vehicle speed reductions), improved education and training, and enhanced vehicle design.

Safer roads and roadsides

The safety of pedestrians is compromised to a large extent by the design and operation of the road transport system and much of the literature has stressed the importance of separating pedestrians from motorised traffic either in time or in space. This is usually addressed through the use of well maintained footpaths, barrier fencing and provision of pedestrian crossings. The findings showed that the majority of serious casualties occur while crossing midblock road sections. Provision of appropriately placed crossing facilities with enhanced safety features such as raised crosswalks, highly visible crossings, kerb extensions and advanced warning signs could therefore be beneficial. In addition, given that a proportion of younger children are involved in crashes whilst emerging from parked vehicles, the placement of parking bays where there are children crossing could be reconsidered, in conjunction with barrier fencing to prevent children crossing in these locations.

Safer speeds

As noted above, moderation of vehicle speeds - especially to speeds not exceeding 30 or 40 km/h - is critical for pedestrian safety. This can be achieved through adoption of low urban speed limits. Given that a high proportion of injuries occur on roads zoned at 50 km/h, we would argue that lower speeds in areas of high pedestrian activity, in the order of 30-40 km/h

could result in dramatic decreases in pedestrian casualty collisions. Additional measures to increase speed limit compliance and adoption of appropriate travel speeds include out-of-vehicle Intelligent Transport System (ITS) applications (e.g., dynamic messaging in the form of active speed warning signs and variable messaging signs) and introduction of traffic calming measures (e..g, pavement narrowing, refuge islands, alternations to the road surface, speed humps, roundabouts and gateway treatments). In 'best-practice' designs, these physical modifications to the roadway are part of an overall design concept giving vulnerable road users greater priority while discouraging high-speed through traffic.

Safe vehicles

Current design of vehicle structures, particularly frontal structures and vehicle mass contribute significantly to the severity of pedestrian injuries. In previous years, there has been no mechanism for determining a vehicle's performance in a pedestrian collision. However, the Australian New Car Assessment Program (ANCAP) has recently been extended to include a pedestrian test, consisting of dummy components projected at the vehicle's front and bonnet to evaluate head, upper leg and knee injury risk [21,22]. It is expected that this process will have a positive impact on safer vehicle choices for both drivers and pedestrians. Moreover, given the evidence that driveway collisions may contribute significantly to child pedestrian injuries, it is worth considering the widespread introduction of forward and rear warning systems including sensors, mirrors and cameras.

Safer road users

Given that much of the literature on child safety in traffic focuses on the behaviour of children in traffic, much emphasis has been on education, training and supervision. The evidence suggests that due to immature and less well-developed functional skills, young children are less competent in traffic, experience difficulty in dangerous locations, judging safe gaps in traffic, being distracted by irrelevant information and controlling impulsive reactions [23,24], and that children may not have the developed abilities to interact safely with traffic until at least 11 to 12 years of age. Recent evidence suggests that realistic and targeted training can result in improved gap selection skills and in coping with more complex situations [25,26]. Moreover, there is evidence that parents play a significant role in protecting their children in traffic and teaching adoption of safe road use and traffic skills [8,27]. There are opportunities to enhance parents' knowledge and skills regarding child pedestrian safety.

Conclusions

Although older adults make up the largest percentage of fatal pedestrian collisions, young children's safety as pedestrians is of particular concern in view of their risk of serious injury, their vulnerability in traffic situations and the special value society places on children. This paper examined police-reported crash data and identified crash patterns and associated factors to child pedestrian injury. The findings were discussed in terms of implications for countermeasure development within the Safe System. Some initiatives such as speed reduction measures, provision of enhanced road design and pedestrian facilities, and education/training/supervision programs that have the potential to significantly reduce child pedestrian injury collisions were highlighted.

Notes

[1]A separate examination of this high percentage of child pedestrians being injured or killed at intersections with 'no control' found it was largely due to a definitional issue where it appears police are more likely to record an intersection crash as not having a traffic control if traffic lights are absent. At most intersections, however, where traffic lights are not present, it was found that there is almost always some form of traffic control, usually a 'Stop' or 'Give way' sign.

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Analysis of child pedestrian deaths and serious injuries in Malaysia

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Abstract

Vulnerable road users are at increased risk in many middle-income countries, largely due to rapid motorisation without associated road safety infrastructure initiatives and programs. Pedestrians are one of the most vulnerable road user groups, particularly young children. While crash patterns and causes of collisions amongst pedestrian are established in developing countries, less is known about crash patterns, types and contributing factors to pedestrian trauma in Malaysia. Analyses of fatal and serious injury child pedestrian crashes were undertaken by examining the police-reported crash database. The results identified high rates of pedestrian deaths overall, and high rates of serious injury amongst young children. Young children were at highest risk in rural areas, on major roads with relatively high speed limits and while they were playing on or attempting to cross the road without the aid of crossing facilities. Passenger vehicles and motorcycles were the most frequent striking vehicle. These findings have significant implications for countermeasures to address priority child pedestrian trauma issues in Malaysia including improved road design and reduced speeds on rural roads, as well as supporting education and enforcement initiatives.

Introduction

Each year an estimated 1.3 million people die on the world's roads [1]. Even more alarming is the injury rate associated with road trauma: each year up to 50 million people are injured or disabled worldwide in road traffic crashes [2]. The World Health Organization (WHO) also reports that a high proportion of these deaths and injuries (up to 90%) occur in low- and middle-income countries, and this proportion is increasing.

In many middle-income and developing countries, vulnerable road users are at increased risk and these groups include pedestrians, cyclists and motorcyclists, and the young and elderly. Pedestrians are one of the most vulnerable road user groups, largely due to their lack of protection and limited biomechanical tolerance to violent forces when impacted by a vehicle.

Malaysia is a rapidly developing country and the level of motorisation has increased dramatically in the last two decades. In Malaysia, the number of registered per 100,000 population has increased by 71.1% from 1994 (36,986) to 2007 (63,319) [3]. This rate ranks Malaysia as one of the highest motorised middle-income countries in the world, with a rate higher than many high-income countries (UK: 56,489; France: 6477;